

1 1. A method for preparing a lactase microcarrier for hydrolyzing lactose in a liquid, the
2 method comprising:
3 transforming a food-grade lactic acid bacterium with a DNA construct, wherein the
4 DNA construct comprises a promoter sequence operatively linked to a DNA sequence encoding
5 a β -galactosidase;
6 culturing the bacterium under conditions that enable expression of the β -galactosidase
7 such that the bacterium exhibits a β -galactosidase activity of at least 4000 Miller Units; and
8 permeabilizing the bacterium.

1 2. A method of hydrolyzing lactose in a liquid, the method comprising:
2 contacting the lactase microcarrier of claim 1 with the liquid containing lactose for a
3 time sufficient to hydrolyze the lactose.

1 3. The method of claim 1, wherein the lactic acid bacterium is selected from the group
2 consisting of *Streptococcus*, *Aerococcus*, *Carnobacterium*, *Enterococcus*, *Erysipelothrix*, *Gemella*,
3 *Globicatella*, *Lactobacillus*, *Lactococcus*, *Bidobacteria*, *Leuconostococcus*, *Pediococcus*,
4 *Streptococcus*, *Tetragenococcus*, and *Bagococcus* bacteria.

1 4. The method of claim 1, wherein the lactic acid bacterium is a *Lactococcus lactis*.

1 5. The method of claim 1, wherein the DNA sequence encoding β -galactosidase is from
2 a *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, *Bifobacterium species*, *Aspergillus*
3 *niger*, *Aspergillus oryzae*, *Kluyveromyces fragilis*, *Kluyveromyces lactis*, *Bacillus subtilis* or
4 *Arthrobacter species*.

1 6. The method of claim 1, wherein the promoter is from a gene that encodes an
2 antimicrobial peptide.

1 7. The method of claim 1, wherein the promoter is from a gene that encodes a lantibiotic.

1 8. The method of claim 1, wherein the promoter is a nisin gene promoter.

1 9. The method of claim 1, wherein the promoter is a nisA promoter.

Sub A¹₂
10. The method of claim 1, wherein the bacterium is permeabilized by an agent selected from the group consisting of a chemical, a solvent, or a detergent.

1 11. The method of claim 1, wherein the bacterium is permeabilized by ethanol,
2 isopropanol, or a combination of ethanol and isopropanol.

Sub A³₂
12. The method of claim 9, wherein the detergent is selected from the group consisting of deoxycholate, sodium dodecyl sulfate, rhamnolipid, and chenodeoxycholate.

3 13. The method of claim 1, wherein the bacterium exhibits a β -galactosidase activity of
4 at least 10,000 Miller Units.

1 14. The method of claim 2, wherein the liquid is a milk or a whey product.

1 15. The method of claim 2, wherein hydrolysis of lactose is performed at 4°C.

1 16. The method of claim 15, wherein at least 90% of the lactose is hydrolyzed in 6 hours
2 by a concentration of enzyme which equivalent to 5000 ONPG units/liter.

1 17. The method of claim 2, wherein hydrolysis of lactose is performed at 55°C.

1 18. The method of claim 17, wherein at least 90% of the lactose is hydrolyzed in 2 hours
2 by a concentration of enzyme equivalent to 5000 ONPG units/liter.

1 19. A method for hydrolyzing lactose, the method comprising:
2 obtaining a permeabilized lactic acid bacterium containing a β -galactosidase, wherein
3 the bacterium exhibits a β -galactosidase activity of at least about 4000 Miller units; and
4 contacting the permeabilized bacterium with a liquid containing lactose for a time
5 sufficient to hydrolyze the lactose.

1 20. The method of claim 19, wherein the lactic acid bacterium is selected from the group
2 consisting of *Streptococcus*, *Aerococcus*, *Carnobacterium*, *Enteroccus*, *Erysipelothrix*, *Gemella*,
3 *Globicatella*, *Lactobacillus*, *Lactococcus*, *Bidobacteria*, *Leuconostococcus*, *Pediococcus*,
4 *Streptococcus*, *Tetragenococcus*, and *Bagococcus* bacteria.

1 21. The method of claim 19, wherein the lactic acid bacterium is a *Lactococcus lactis*.

1 22. The method of claim 19, wherein the β -galactosidase is encoded by a heterologous
2 gene.

1 23. The method of claim 19, wherein the β -galactosidase is a *Streptococcus thermophilus*
2 β -galactosidase.

1 24. The method of claim 19, wherein the bacterium exhibits a β -galactosidase activity of
2 at least about 10,000 Miller Units.

1 25. A permeabilized lactic acid bacterium containing a heterologous β -galactosidase,
2 wherein the bacterium exhibits a β -galactosidase activity of at least about 4000 Miller Units.

1 26. The permeabilized bacterium of claim 25, wherein the bacterium is selected from the
2 group consisting of *Streptococcus*, *Aerococcus*, *Carnobacterium*, *Enterococcus*, *Erysipelothrix*,
3 *Gemella*, *Globicatella*, *Lactobacillus*, *Lactococcus*, *Bidobacteria*, *Leuconostococcus*,
4 *Pediococcus*, *Streptococcus*, *Tetragenococcus*, and *Bagococcus bacteria*.

1 27. The permeabilized bacterium of claim 25, wherein the bacterium is a *Lactococcus*
2 *lactis*.

1 28. The permeabilized bacterium of claim 25, wherein the β -galactosidase is a
2 *Streptococcus thermophilus* β -galactosidase.

1 29. The permeabilized bacterium of claim 25, wherein the bacterium is in a lyophilized
2 form, in a concentrated cell suspension, or immobilized.

1 30. A composition comprising the permeabilized bacterium of claim 25.

1 31. A food product for use with a dairy product, wherein the food product comprises a
2 permeabilized bacterium of claim 25.

1 32. A method of administering lactase to a mammal, the method comprising
2 administering to the mammal a permeabilized bacterium of claim 25.

1 33. The method of claim 32, wherein the permeabilized bacterium is administered orally.

1 34. A reduced lactose dairy product comprising a dairy product and a permeablized
2 *Lactococcus lactis*.

1 35. The product of claim 34, wherein the *Lactococcus lactis* contains a *Streptococcus*
2 *thermophilus* β -galactosidase.

1 36. The reduced lactose dairy product of claim 34, wherein the dairy product is milk.